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A comparative study on TPACK self-efficacy of prospective Biology teachers from the faculties of education & science

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Abstract

Due to different implementations in the execution of the teaching profession in Turkey, the aim of the study was to compare the Technological Pedagogical Content Knowledge (TPACK) self-efficacy levels of prospective Biology teachers' Faculty of Education (FoE) and the Faculty of Science (FoS) between 2013- 2014 and 2017-2018 academic years. The research was carried out using a screening model, one of the quantitative research techniques. The participants of this study were selected via convenience sampling method, and consisted of a total of 342 volunteer prospective teachers, 138 from the faculty of education and 204 from the faculty of science. The data collection tool was the TPACK self-efficacy scale. The data were analyzed using independent sample T-test and one-way ANOVA, separately in five academic years. The results revealed that the TPACK self-efficacy scores of prospective Biology teachers of the faculty of education was higher than those who graduated from the faculty of science. In addition, when compared over the five academic years, it was also found that there was a significant difference among them in favor of the prospective Biology teachers of the faculty of education.

Keywords: TPACK, Self-efficacy, biology, teacher candidates, faculty of education, faculty of science

1. Introduction

With the rapid development and change of technology day by day, differences come into existence in every aspect of our lives. These differences sometimes lead to the emergence of new professions and also reveal the need for the integration of professions with new technologies. The teaching profession has also become one of the professions that need to keep up with this change. From this point it is very necessary to train

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qualified teachers in order to achieve the goals set in the education system and to reach international standards.

As a necessity of the teaching profession, it is expected to be individuals who have both the high level of knowledge, skills and competences required by the era and who have high self-efficacy. The concept of self-efficacy is defined by Bandura (1997) as an individual's self-judgment about to organize the necessary activities and the capacity to do a certain performance successfully. In other word it is a belief of the ability of the individual's to perform an action. Self-efficacy focuses on one's self-belief to achieve any task, not capable of doing it. Self-efficacy has also been one of the concepts that are emphasized in terms of the teaching profession. Self-efficacy of teacher candidates is considered as one of the factors that affect their success and goals in their professional life (Çakıroğlu, Çakıroğlu & Boone, 2005). Teacher self- efficacy has a strong relationship with both the patience, enthusiasm, and commitment of the teacher in the profession, as well as the characteristics such as students' success, motivation, and self-efficacy belief (Tschannen-Morana, & Woolfolk Hoyb, 2001). It is inevitable for teachers who have high self-efficacy are more willing, more patient and more attentive of their profession. Pedagogical Content Knowledge (PCK) defined by Shulman (1986) as a synthesis of content knowledge, curriculum knowledge and educational knowledge. PCK is fundemental by the teaching profession but it does not provide the competencies to meet today's needs. As a necessity of the information and communication age, teachers who have also technological knowledge in addition to PCK that can meet today's needs and can integrate this into the teaching process. In fact, there are a wide variety of studies on the integration of technology into the teaching process (Angeli & Valanides,2005; Lundeberg, Bergland, Klyczek, & Hoffman, 2003; Margerum-Leys, & Marx, 2002; Niess, 2005; Pierson; 1999) but Koehler & Mishra (2005) distinctly introduced a new concept, Technological Pedagogical Content Knowledge (TPACK), to the literature, which reveals the necessity of technology in the teaching process. Some of the researchers made various definitions for TPACK which guides teachers in order to gain information on the integration of information and communication technologies (Cox & Graham, 2009; Harris, Mishra, & Koehler, 2009; Kereluik, Mishra, & Koehler, 2011; Pierson & Borthwick, 2010). Graham et al (2009). With TPACK applications, it is emphasized that a teacher should be able to combine technology with pedagogical strategies, to integrate it into their classes or outside learning places and to organize the effect of understanding of the subject matter.

It is very important to understand the content knowledge, pedagogical knowledge and technological knowledge, TPACK because it is a requirement in the teaching process of teachers and teacher candidates who are well qualified to meet today's needs, at the desired level. In particular, teachers' perceptions of their ability to use technology effectively in lessons and their abilities of teaching affect their self-efficacy levels (Abbitt & Klett, 2007; Doukakis, Koilias & Chionidou-Moskofoglou; 2011). The teachers who

have high level of self-efficacy on technology integration tend to be more successful and self-confidence about integrating technologies to the lesson (Nathan, 2009; Wang et al. 2004).

In our country the task of training teachers in the universities was given to the Faculties of Education in 1982 by Council of Higher Education. In education faculties, teacher candidates are taught by blending field courses, educational science courses and field education courses during their undergraduate education, and it is also aimed to train these candidates with the spirit and consciousness of teaching. The students who successfully graduate from the Faculty of Education, which constitutes the pre-service part of the teaching profession, now provides the first condition on the way to become a teacher. Although it is expected to be met by the graduates of the faculty of education in order to supply the fulfillment of teacher needs in our country, some various implementation decisions regarding of this have been taken by the Council of Higher Education time to time. One of these decisions is the Pedagogical Formation Certificate Program (PFCP), which paves the way to become a teacher for the graduates or senior students in the faculty of science. With this program, accelerated training of education is given to the graduates/senior students of the Faculty of science for a certain fee by the faculty of education. Although teacher training called PFCP is carried out by the faculties of education, it is thought that such practices are not suitable and may cause some problems in the long run because it is very difficult to gain teaching qualifications with a short-term education.

In the literature there are several studies were carried out the TPACK self-efficacy of teachers (Bakar, Maat & Rosli, Blonder & Rap; 2017; Byker, Putman, Polly & Handler, 2018; Dong, Xu, Chai & Zhai, 2020; Yıldız Durak; 2019; Lee & Tsai, 2010; Moreira-Fontán, García-Señorán, Conde-Rodríguez & González, 2019; Setiawan & Phillipson, 2020; Şimşek &Sarsar, 2019) and pre-service teachers (Abbitt, 2011; Balçın & Ergün, 2018; Byker, Putman, Polly & Handler, 2018; Jin & Harp, 2020; Joo, Park & Lim,2018; Lee, Kim &Lee, 2017; Kapıcı &Akçay, 2020; Keser, Yılmaz & Yılmaz, 2015; Taflı & Atıcı, 2018; Yerdelen-Damar, Boz, & Aydın-Günbatar, 2017). However any study was found on determining and comparing TPACK self-efficacy of the two faculties' teacher candidates.

As a gap and due to the differences in the execution of the teaching profession in our country, the aim of this study is to compare the TPACK self-efficacy levels of the prospective Biology teachers' of the Faculty of Education (FoE) and the Faculty of Science (FoS). According to reveal the problem of this study, the following sub-problems were sought as:

1- Is there a significant difference between the TPACK self-efficacy of prospective Biology teachers' of the faculty of education and the faculty of science in the 2013-2014 academic years?

2- Is there a significant difference between the TPACK self-efficacy of prospective Biology teachers' of the faculty of education and the faculty of science in the 2014-2015 academic years?

3- Is there a significant difference between the TPACK self-efficacy of prospective Biology teachers' of the faculty of education and the faculty of science in the 2015-2016 academic years?

4- Is there a significant difference between the TPACK self-efficacy of prospective Biology teachers' of the faculty of education and the faculty of science in the 2016-2017 academic years?

5- Is there a significant difference between the TPACK self-efficacy of prospective Biology teachers' of the faculty of education and the faculty of science in the 2017-2018 academic years?

6- Is there a significant difference between the TPACK self-efficacy scores of the prospective Biology teachers' of the faculty of science over the five academic years?

7- Is there a significant difference between the TPACK self-efficacy scores of the prospective Biology teachers of the faculty of education over the five academic years?

2. Method

2.1 Model of the study

This study is conducted with the screening model, which is one of the quantitative research techniques. Screening model aims to describe the past and the present situations as it is. This model also used comparing the relationship between the variables and collecting the data over a period of time. Any attempt is made to change or influence the variables of the study (Karasar, 2006). According to the obtained data from the sample which reflect the characteristics of the universe, it is obtained general knowledge about the universe (Fraenkel & Wallen, 2009).

2.2 Participants of the study

The participants of the study were selected using convenience sampling method, and were composed of 342 prospective Biology teachers in one of the state universities in Turkey. As a distribution of the participants; 138 were the senior students in the faculty of education, and 204 were those who received bachelor's degree from the faculty of science and completing the pedagogical formation certificate program between 2013-2014 and 2017-2018 academic years. (See Table 1).

Table 1: The distribution of the participants

Academic Year	Faculty of science	Faculty of education	Total
2013-2014	40	38	78
2014-2015	45	34	79
2015-2016	39	26	65
2016-2017	40	20	60
2017-2018	40	20	60
Total	204	138	342

2.3 Data Collection Tool

In this study, Technological Pedagogical Content Knowledge (TPACK) self-efficacy scale, which was developed by the researcher, was used as a data collection tool. The scale's validity and reliability analyzes, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were completed at the end of fall semester of 2013/2014 academic year. As a result of the analysis the Cronbach Alpha reliability coefficient of the scale was calculated as .969. The scale consists of 39 items with 6 sub-dimension of TPACK. The Cronbach Alpha internal consistency coefficients of the sub-dimensions of the scale are calculated as: 1st dimension; 0.888; 2nd dimension: 0.915, 3rd dimension; 0.902; 4th sub-dimension: 0,955; 5th sub-dimension: 0,889 and 6th sub-dimension: 0,924.

2.4 Data Analysis

In this study, SPSS 22 program was used to analyze the data. According to the analysis of the total scores of the data, independent samples t-test, one-way ANOVA test with Tamhane's T2 was applied with the significance level of 0.05.

3. Results

1. **Results of the First Sub-Problem**

Regarding to the first sub-problem of the study; the analysis was calculated whether there is a significant difference between the TPACK self-efficacy of prospective Biology teachers' of the faculty of education and the faculty of science in the 2013-2014 academic years. Primarily normality test was conducted in order to determine if the data of the groups were distributed normally or not. The results of the Shapiro-Wilk test were evaluated ($n<50$) for the two groups and according to the obtained values (.833 and .155) and the other related values, it was concluded that the data of both groups had a normal distribution.

In order to compare the TPACK self-efficacy with the sub-dimensions and the whole scale scores between the two faculties of prospective Biology teachers' in 2013-2014, independent sample t-test was conducted and the results was indicated in Table 2.

Table 2. Independent Samples T-Test Results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2013-2014.

2013-2014 Academic Years	n	Mean	Ss	Sd	T	p
Technological Knowledge-TK (Science Faculty)	40	63,3	15,18	76	-2,422	0,01
Technological Knowledge- TK (Education Faculty)	38	70,1	9,01			
Pedagogical Knowledge-PK (Science Faculty)	40	70,8	12,78	76	-4,624	0,000
Pedagogical Knowledge-PK (Education Faculty)	38	82,3	8,91			
Content Knowledge-CK (Science Faculty)	40	72,2	12,71	76	-7,262	0,000
Content Knowledge-CK (Education Faculty)	38	88,4	5,94			
Technological Pedagogical Knowledge- TPK (Science Faculty)	40	69,2	14,64	76	-6,585	0,000
Technological Pedagogical Knowledge- TPK (Education Faculty)	38	85,9	6,54			
Pedagogical Content Knowledge-PCK (Science Faculty)	40	71,1	12,93	76	-7,907	0,000
Pedagogical Content Knowledge-PCK (Education Faculty)	38	88,8	5,78			
Technological Content Knowledge- TCK (Science Faculty)	40	68,7	13,64	76	-6,268	0,000
Technological Content Knowledge- TCK (Education Faculty)	38	84,4	7,94			
Technological Pedagogical Content Knowledge- TPCK (Science Faculty)	40	69,4	12,36	76	-6,596	0,000
Technological Pedagogical Content Knowledge- TPCK (Education Faculty)	38	83,5	5,5			

According to the Table 2, it was seen that the TPACK self-efficacy scores of the prospective Biology teachers of FoE was higher than the FoS candidates in 2013-2014 academic years. For the sub-dimensions and the scale values were calculated as; technological knowledge (TK) t78=-2,422 & p=,001 (p<,05), pedagogical knowledge (PK) t78=-4,624 & p=,000 (p<,05), content knowledge (CK) t78=-7,262 & p=,000 (p<,05), technological pedagogical knowledge (TPK) t78=-6,585 & p=,000 (p<,05), pedagogical content knowledge (PCK) t78=-7,907 & p=,000 (p<,05), technological content knowledge (TCK) t78=-6,268 & p=,000 (p<,05) and the scale of TPACK t78=-6,596 & p=,000 (p<,05). As a result of this, it was found that there was a significant difference in favor of faculty of education prospective Biology teachers in the 2013-2014 academic years. Another comparison of these groups was shown in Figure1. According to the average scores of science and education faculty prospective Biology teachers about TPACK scale with sub-dimensions in 2013-2014 was found respectively as; TK (63-70), PK (71-82), CK (72-88), TPK (69-86), PCK (71-89), TCK (69-84) and TPACK (69-84).

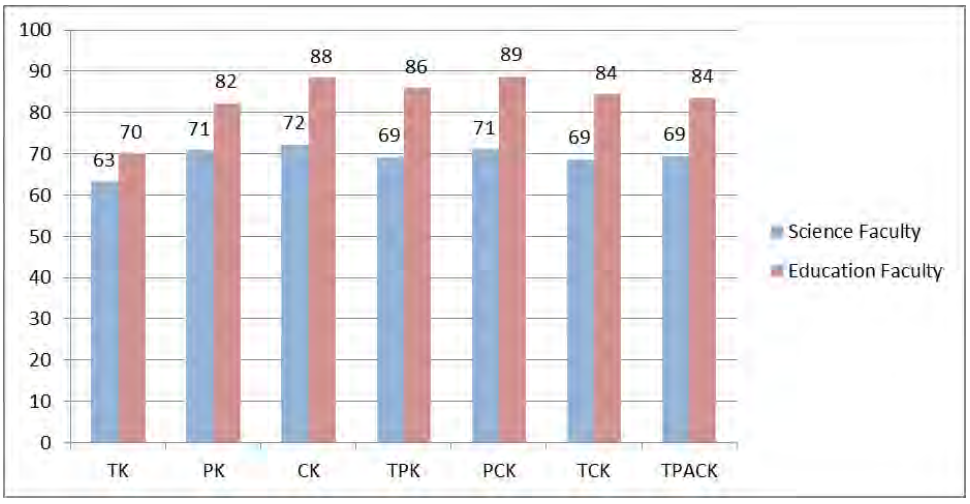

Figure 1. The comparison average results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2013-2014

2. **Results of the 2nd Sub-Problem**

Regarding to the second sub-problem of the study; the analysis were calculated whether there is a significant difference between the TPACK self-efficacy of prospective Biology teachers of the faculty of education and the faculty of science in the 2014-2015 academic years. Firstly, normality test was conducted in order to determine if the data of the groups were distributed normally or not. The results of the Shapiro-Wilk test were evaluated (n<50) for the two groups and according to the obtained values (.710 and .670) and the other related values, it was concluded that the data of both groups had a normal distribution.

In order to compare the TPACK self-efficacy with the sub-dimensions and the whole scale scores between the two faculties of prospective Biology teachers' in 2014-2015, independent sample t-test was conducted and the results was indicated in Table 3.

Table 3. Independent Samples T-Test Results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2014-2015.

2014-2015 Academic Years	n	Mean	Ss	Sd	T	p
Technological Knowledge-TK (FoS)	45	72	8,99	77	-2,022	0,013
Technological Knowledge- TK (FoE)	34	75,8	7,65			
Pedagogical Knowledge-PK (FoS)	45	78,3	6,73	77	-5,883	0,000
Pedagogical Knowledge-PK (FoE)	34	87,7	7,26			
Content Knowledge-CK (FoS)	45	79,5	8,71	77	-5,782	0,000
Content Knowledge-CK (FoE)	34	90,1	6,98			

Technological Pedagogical Knowledge- TPK (FoS)	45	76,9	9,12	77	-5,495	0,000
Technological Pedagogical Knowledge- TPK (FoE)	34	88,1	8,63			
Pedagogical Content Knowledge-PCK (FoS)	45	78,6	8,81	77	-5,802	0,000
Pedagogical Content Knowledge-PCK (FoE)	34	90,4	9,03			
Technological Content Knowledge- TCK (FoS)	45	78,8	11,08	77	-5,826	0,000
Technological Content Knowledge- TCK (FoE)	34	89,2	8,69			
Technological Pedagogical Content Knowledge- TPCK (FoS)	45	77,11	7,21	77	-6,373	0,000
Technological Pedagogical Content Knowledge- TPCK (FoE)	34	87,3	6,82			

According to the Table 3, it was seen that the TPACK self-efficacy scores of the prospective Biology teachers of FoE was higher than the FoS candidates in 2014-2015 academic years. For the sub-dimensions and the scale values were calculated as; technological knowledge (TK) t79=-2,022& p=,013 (p<,05), pedagogical knowledge (PK) t79=-5,883 & p=,000 (p<,05), content knowledge (CK) t79=-5,782& p=,000 (p<,05), technological pedagogical knowledge (TPK) t79=-5,495 & p=,000 (p<,05), pedagogical content knowledge (PCK) t79=-5,802& p=,000 (p<,05), technological content knowledge (TCK) t79=-5,826 & p=,000 (p<,05) and the scale of TPACK t79=-6,373 & p=,000 (p<,05). As a result of this, it was found that there was a significant difference in favor of faculty of education prospective Biology teachers in the 2014-2015 academic years. Another comparison of these groups was shown in Figure2. According to the average scores of science and education faculty prospective Biology teachers about TPACK scale with sub-dimensions in 2014-2015 was found respectively as; TK (72-76), PK (78-88), CK (80-90), TPK (77-88), PCK (79-90), TCK (79-89) and TPACK (77-87).

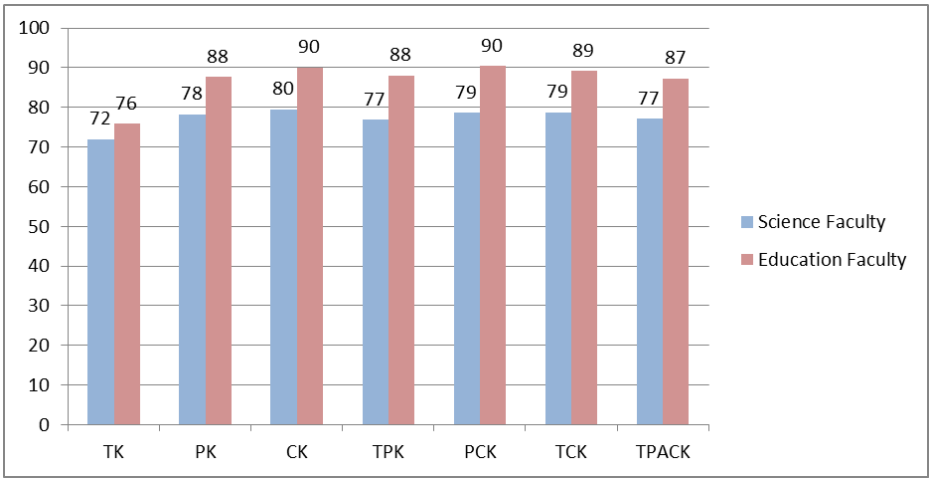

Figure 2. The comparison average results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2014-2015

3. Results of the 3rd Sub-Problem

Regarding to the third sub-problem of the study; the analysis were calculated whether there is a significant difference between the TPACK self-efficacy of prospective Biology teachers of the faculty of education and the faculty of science in the 2015-2016 academic years. Primarily normality test was conducted in order to determine if the data of the groups were distributed normally or not. The results of the Shapiro-Wilk test were evaluated (n<50) for the two groups and according to the obtained values (.71 and .737) and the other related values, it was concluded that the data of both groups had a normal distribution.

In order to compare the TPACK self-efficacy with the sub-dimensions and the whole scale scores between the two faculties of prospective Biology teachers' in 2015-2016, independent sample t-test was conducted and the results was indicated in Table 4. According to the Table 4, it was seen that the TPACK self-efficacy scores of the prospective Biology teachers of FoE was higher than the FoS teacher candidates in 2015-2016.

Table 4. Independent Samples T-Test Results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2015-2016.

2015-2016 Academic Years	n	Mean	Ss	Sd	T	p
Technological Knowledge-TK (FoS)	39	68,8	11,02	63	-4,748	0,000
Technological Knowledge- TK (FoE)	26	80,1	5,83			
Pedagogical Knowledge-PK (FoS)	39	74,4	7,19	63	-9,781	0,000
Pedagogical Knowledge-PK (FoE)	26	90,3	4,97			
Content Knowledge-CK (FoS)	39	75,7	7,98	63	-7,669	0,000
Content Knowledge-CK (FoE)	26	89,1	4,83			
Technological Pedagogical Knowledge- TPK (FoS)	39	76,1	8,15	63	-6,746	0,000
Technological Pedagogical Knowledge- TPK (FoE)	26	88,1	4,78			
Pedagogical Content Knowledge-PCK (FoS)	39	77,1	8,03	63	-7,744	0,000
Pedagogical Content Knowledge-PCK (FoE)	26	90,7	5,06			
Technological Content Knowledge- TCK (FoS)	39	76,2	8,93	63	-6,343	0,000
Technological Content Knowledge- TCK (FoE)	26	88,2	4,32			
Technological Pedagogical Content Knowledge- TPCK (FoS)	39	74,5	6,26	63	-9,82	0,000
Technological Pedagogical Content Knowledge- TPCK (FoE)	26	88	3,12			

For the sub-dimensions and the scale values were calculated as; technological knowledge (TK) t65=-4,748& p=,000 (p<,05), pedagogical knowledge (PK) t65=-9,781& p=,000 (p<,05), content knowledge (CK) t65=-7,669& p=,000 (p<,05), technological pedagogical knowledge (TPK) t65=-6,746 & p=,000 (p<,05), pedagogical content knowledge (PCK) t65=-7,744& p=,000 (p<,05), technological content knowledge (TCK) t65=-6,343& p=,000 (p<,05) and the scale of TPACK t65=-9,82& p=,000 (p<,05). As a result of this, it was

found that there was a significant difference in favor of faculty of education prospective Biology teachers in the 2014-2015 academic years.

Another comparison of these groups was shown in Figure 3. According to the average scores of science and education faculty prospective Biology teachers about TPACK scale with sub-dimensions in 2015-2016 was found respectively as; TK (69-80), PK (74-90), CK (76-89), TPK (76-88), PCK (77-91), TCK (76-88) and TPACK (75-88).

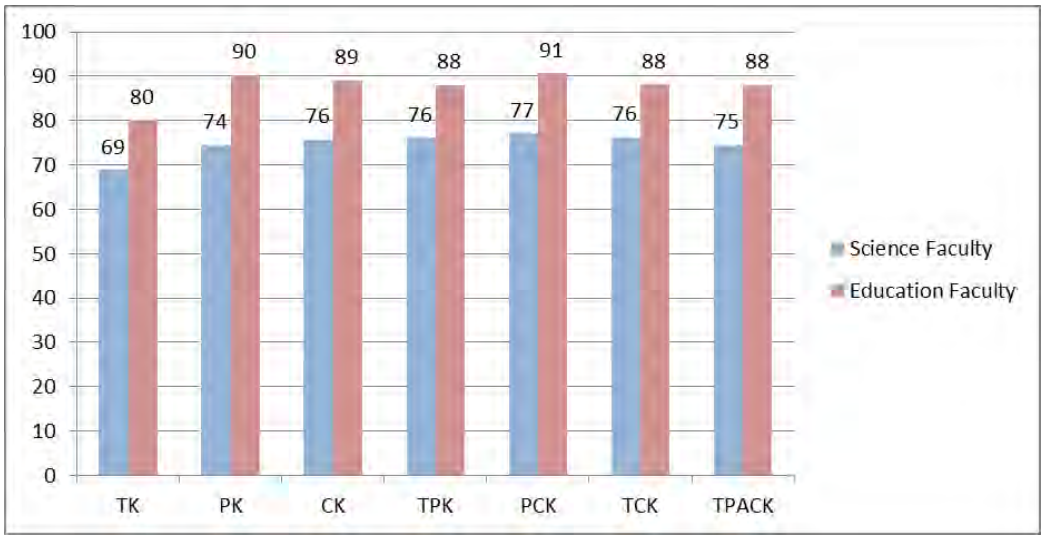

Figure 3. The comparison average results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2015-2016

4. **Results of the 4th Sub-Problem**

Regarding to the fourth sub-problem of the study; the analysis was calculated whether there is a significant difference between the TPACK self-efficacy of prospective Biology teachers of the faculty of education and the faculty of science in the 2016-2017 academic years. Primarily normality test was conducted in order to determine if the data of the groups were distributed normally or not. The results of the Shapiro-Wilk test were evaluated ($n<50$) for the two groups and according to the obtained values (.363 and .55), and the other related values, it was concluded that the data of both groups had a normal distribution.

In order to compare the TPACK self-efficacy with the sub-dimensions and the whole scale scores between the two faculties of prospective Biology teachers' in 2016-2017, independent sample t-test was conducted and the results was indicated in Table 5.

Table 5. Independent Samples T-Test Results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2016-2017

2016-2017 Academic Years	n	Mean	Ss	Sd	T	p
Technological Knowledge-TK (FoS)	40	69,7	8,24	58	-5,26	0,000
Technological Knowledge- TK (FoE)	20	80,7	6,19			
Pedagogical Knowledge-PK (FoS)	40	76,7	10,9	58	-6,72	0,000
Pedagogical Knowledge-PK (FoE)	20	90,3	4,76			
Content Knowledge-CK (FoS)	40	77,7	9,3	58	-7,18	0,000
Content Knowledge-CK (FoE)	20	90,9	4,94			
Technological Pedagogical Knowledge- TPK (FoS)	40	73,4	10,39	58	-7,454	0,000
Technological Pedagogical Knowledge- TPK (FoE)	20	88,8	5,65			
Pedagogical Content Knowledge-PCK (FoS)	40	77,3	10,57	58	-7,276	0,000
Pedagogical Content Knowledge-PCK (FoE)	20	92	5,06			
Technological Content Knowledge- TCK (FoS)	40	73,5	10,2	58	-6,189	0,000
Technological Content Knowledge- TCK (FoE)	20	89,5	7,59			
Technological Pedagogical Content Knowledge- TPCK (FoS)	40	74,8	8,54	58	-8,536	0,000
Technological Pedagogical Content Knowledge- TPCK (FoE)	20	88,9	4,22			

According to the Table 5, it was seen that the TPACK self-efficacy scores of the prospective Biology teachers of FoE was higher than the FoS candidates in 2016-2017 academic years. For the sub-dimensions and the scale values were calculated as; technological knowledge (TK) t60=-5,26 & p=,000 (p<,05), pedagogical knowledge (PK) t60=-6,72& p=,000 (p<,05), content knowledge (CK) t60=-7,18& p=,000 (p<,05), technological pedagogical knowledge (TPK) t60=-7,454& p=,000 (p<,05), pedagogical content knowledge (PCK) t60=-7,276& p=,000 (p<,05), technological content knowledge (TCK t60=-6,189& p=,000 (p<,05) and the scale of TPACK t60=-8,536& p=,000 (p<,05). As a result of this, it was found it was found that there was a significant difference in favor of faculty of education prospective Biology teachers in the 2016-2017 academic years.

Another comparison of these groups was shown in Figure 4. According to the average scores of science and education faculty prospective Biology teachers about TPACK scale with sub-dimensions in 2016-2017 was found respectively as; TK (70-81), PK (77-90), CK (78-91), TPK (73-89), PCK (77-92), TCK (74-90) and TPACK (75-89).

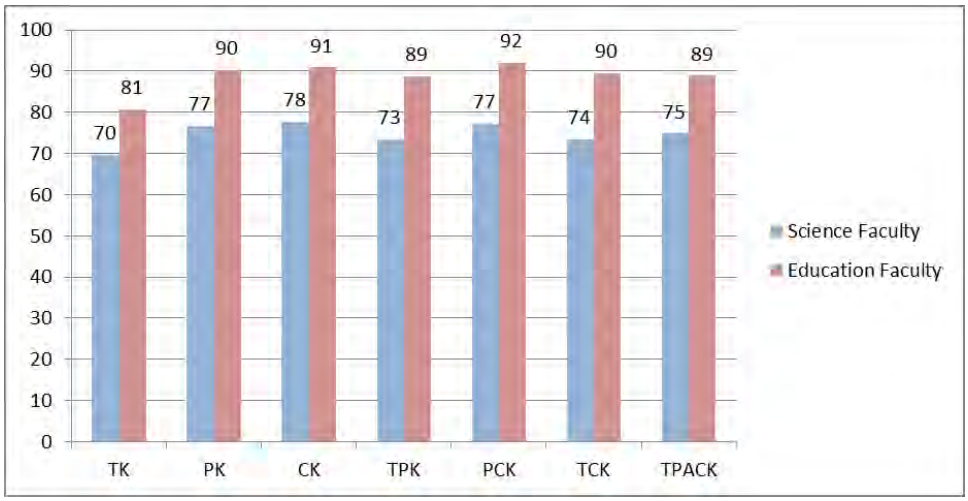

Figure 4. The comparison average results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2016-2017.

5. Results of the 5th Sub-Problem

Regarding to the fifth sub-problem of the study; the analysis were calculated whether there is a significant difference between the TPACK self-efficacy of prospective Biology teachers of the faculty of education and the faculty of science in the 2017-2018 academic years. Primarily normality test was conducted in order to determine if the data of the groups were distributed normally or not. The results of the Shapiro-Wilk test were evaluated (n<50) for the two groups and according to the obtained values (.201 and .68), and the other related values, it was concluded that the data of both groups had a normal distribution.

In order to compare the TPACK self-efficacy with the sub-dimensions and the whole scale scores between the two faculties of prospective Biology teachers' in 2017-2018, independent sample t-test was conducted and the results was indicated in Table 6.

Table 6. Independent Samples T-Test Results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2017-2018

2017-2018 Academic Years	n	Mean	Ss	Sd	T	p
Technological Knowledge-TK (FoS)	40	67,5	9,78	58	-6,472	0,000
Technological Knowledge- TK (FoE)	20	80,9	6,1			
Pedagogical Knowledge-PK (FoS)	40	72,9	8,4	58	-9,568	0,000
Pedagogical Knowledge-PK (FoE)	20	92	4,15			
Content Knowledge-CK (FoS)	40	75,07	7,89	58	-7,927	0,000
Content Knowledge-CK (FoE)	20	91,1	6,2			
Technological Pedagogical Knowledge- TPK (FoS)	40	73,1	7,36	58	-9,201	0,000
Technological Pedagogical Knowledge- TPK (FoE)	20	90,2	5,35			

Pedagogical Content Knowledge-PCK (FoS)	40	75,5	6,82	58	-9,361	0,000
Pedagogical Content Knowledge-PCK (FoE)	20	92,2	5,83			
Technological Content Knowledge- TCK (FoS)	40	73,8	6,96	58	-8,791	0,000
Technological Content Knowledge- TCK (FoE)	20	89,1	4,77			
Technological Pedagogical Content Knowledge- TPCK (FoS)	40	73,1	6,26	58	-10,514	0,000
Technological Pedagogical Content Knowledge- TPCK (FoE)	20	89,6	4,44			

According to the Table 6, it was seen that the TPACK self-efficacy scores of the prospective Biology teachers of FoE was higher than the FoS candidates in 2017-2018 academic years. For the sub-dimensions and the scale values were calculated as; technological knowledge (TK) t60=-6,472& p=,000 (p<,05), pedagogical knowledge (PK) t60=-9,568 & p=,000 (p<,05), content knowledge (CK) t60=-7,927& p=,000 (p<,05), technological pedagogical knowledge (TPK) t60=-9,201& p=,000 (p<,05), pedagogical content knowledge (PCK) t60=-9,361& p=,000 (p<,05), technological content knowledge (TCK) t60=-8,791& p=,000 (p<,05) and the scale of TPACK t60=-10,514& p=,000 (p<,05) As a result of this, it was found it was found that there was a significant difference in favor of faculty of education prospective Biology teachers in the 2017-2018 academic years.

Another comparison of these groups was shown in Figure 5. According to the average scores of science and education faculty prospective Biology teachers about TPACK scale with sub-dimensions in 2017-2018 was found respectively as; TK (68-81), PK (73-92), CK (75-91), TPK (73-90), PCK (76-92), TCK (74-89) and TPACK (73-90).

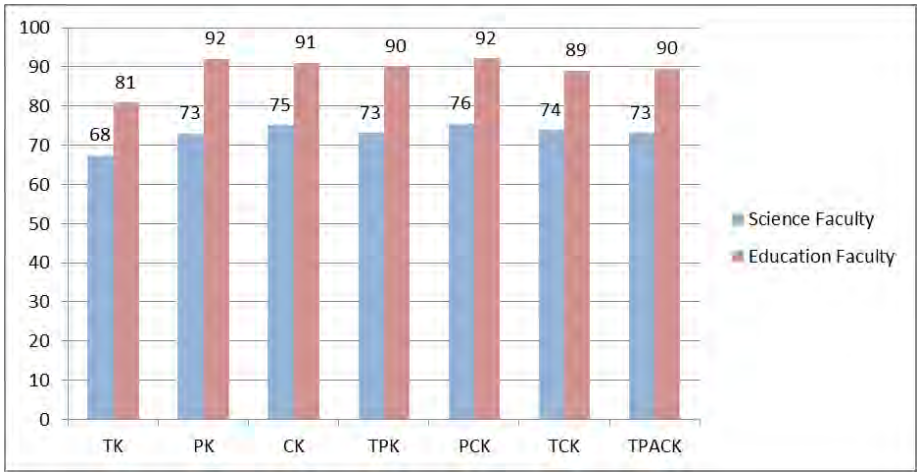

Figure 5. The comparison average results of Prospective Biology teachers (FoS&FoE) about TPACK Self Efficacy in 2017-2018.

6. Results of the 6th Sub-Problem

Regarding to the sixth sub-problem of the study; the analysis were calculated whether there is a significant difference between the TPACK self-efficacy scores of the prospective Biology teachers of the faculty of science over the five academic years. In order to

compare the TPACK self-efficacy with the sub-dimensions and the whole scale scores of science faculty prospective Biology teachers between 2013/2014- 2017/2018 academic years, one-way ANOVA test was conducted and the results was indicated in Table 7.

Table 7. One-way ANOVA Test Results of FoS Prospective Teachers' about TPACK Self Efficacy Scale between 2013-2014 and 2017-2018 Academic Years

TPACK Self Efficacy with sub dimensions (FoS)	Academic Year	n	X	Ss	Sd	F	p
Technological Knowledge-TK	2013-2014	40	63,3	15,18	4/199	3,651	0,007
	2014-2015	45	72	8,99			
	2015-2016	39	68,9	11,03			
	2016-2017	40	69,7	8,25			
	2017-2018	40	67,6	9,78			
	Total	204	68,4	11,16			
Pedagogical Knowledge-PK	2013-2014	40	70,9	12,78	4/199	4,177	0,003
	2014-2015	45	78,4	6,74			
	2015-2016	39	74,5	7,19			
	2016-2017	40	76,7	10,9			
	2017-2018	40	72,9	8,4			
	Total	204	74,8	9,73			
Content Knowledge-CK	2013-2014	40	72,3	12,72	4/199	3,586	0,008
	2014-2015	45	79,6	8,72			
	2015-2016	39	75,7	7,98			
	2016-2017	40	77,7	9,31			
	2017-2018	40	75,1	7,89			
	Total	204	76,2	9,72			
Technological Pedagogical Knowledge- TPK	2013-2014	40	69,2	14,64	4/199	3,621	0,007
	2014-2015	45	77	9,13			
	2015-2016	39	76,1	8,16			
	2016-2017	40	73,4	10,39			
	2017-2018	40	73,2	7,37			
	Total	204	73,8	10,51			
Pedagogical Content Knowledge-PCK	2013-2014	40	71,1	12,94	4/199	3,746	0,006
	2014-2015	45	78,7	8,81			
	2015-2016	39	77	8,04			
	2016-2017	40	77,3	10,58			
	2017-2018	40	75,5	6,82			
	Total	204	76	9,92			
Technological Content Knowledge- TCK	2013-2014	40	68,7	13,64	4/199	3,329	0,012
	2014-2015	45	75,8	11,09			
	2015-2016	39	76,3	8,94			
	2016-2017	40	73,5	10,2			
	2017-2018	40	73,8	6,97			
	Total	204	73,7	10,67			
Technological Pedagogical Content Knowledge- TPCK	2013-2014	40	69,4	12,37	4/199	4,857	0,001
	2014-2015	45	77,1	7,22			
	2015-2016	39	74,9	6,27			
	2016-2017	40	74,9	8,55			
	2017-2018	40	73,1	6,26			
	Total	204	74	8,74			

As a result of one-way ANOVA test, science faculty candidates' TPACK Self-efficacy, scores with all sub dimensions and the whole scale were found as there was a significant difference between the five years' scores.

According to the Table 7, sub-dimensions and the scale values were calculated as; technological knowledge (TK) F199=3,651, p=0,007 (p<,05), pedagogical knowledge (PK) F199=4,177, p=0,003 (p<,05), content knowledge (CK) F199=3,586, p=0,008 (p<,05), technological pedagogical knowledge (TPK) F199=3,621, p=0,007 (p<,05); pedagogical content knowledge (PCK) F199=3,746, p=0,006 (p<,05); technological content knowledge (TCK) F199=3,329, p=0,012 (p<,05) and the whole scale of TPACK F199=4,857, p=0,001 (p<,05). After the examined data of all years, one of the multiple comparison tests, Tamhane's T2 Test, was applied to determine the mean differences. As a result of this test, in 2013-2014, self-efficacy means of science faculty candidates for TK, PK, CK, PCK and TPACK were found as a significant difference from the 2014-2015 years.

7. **Results of the 7th Sub-Problem**

Regarding to the last sub-problem of the study; the analysis was calculated whether there is a significant difference between the TPACK self-efficacy scores of the prospective Biology teachers of the faculty of education over the five academic years. In order to compare the TPACK self-efficacy with the sub-dimensions and the whole scale scores of education faculty prospective Biology teachers between 2013-2014 and 2017-2018 academic years, one-way ANOVA test was conducted and the results was indicated in Table 8.

Table 8. One-way ANOVA Test Results of FoE Prospective Teachers' about TPACK Self Efficacy Scale between 2013-2014 and 2017-2018 Academic Years

TPACK Self Efficacy with sub dimensions (FoE)	Academic Year	n	X	Ss	Sd	F	p
Technological Knowledge-TK	2013-2014	38	70,1	9	4/134	12,139	0,000
	2014-2015	34	75,9	7,66			
	2015-2016	27	79,9	5,78			
	2016-2017	20	80,7	6,2			
	2017-2018	20	80,9	6,1			
	Total	139	76,5	8,45			
Pedagogical Knowledge-PK	2013-2014	38	82,4	8,92	4/134	9,795	0,000
	2014-2015	34	87,8	7,26			
	2015-2016	27	90,3	4,88			
	2016-2017	20	90,4	4,76			
	2017-2018	20	92	4,15			
	Total	139	87,8	7,53			
Content Knowledge-CK	2013-2014	38	88,4	5,94	4/134	1,035	0,391
	2014-2015	34	90,1	6,99			
	2015-2016	27	89,1	4,74			

	2016-2017	20	91	4,95			
	2017-2018	20	91,1	6,21			
	Total	139	89,7	5,93			
Technological Pedagogical Knowledge- TPK	2013-2014	38	86	6,55	4/134	1,58	0,183
	2014-2015	34	88,1	8,64			
	2015-2016	27	88,2	4,79			
	2016-2017	20	88,9	5,65			
	2017-2018	20	90,3	5,36			
	Total	139	88	6,63			
Pedagogical Content Knowledge-PCK	2013-2014	38	88,9	5,78	4/134	1,197	0,315
	2014-2015	34	90,4	9,04			
	2015-2016	27	90,9	5			
	2016-2017	20	92	5,07			
	2017-2018	20	92,2	5,84			
	Total	139	90,6	6,55			
Technological Content Knowledge- TCK	2013-2014	38	84,5	7,94	4/134	2,885	0,025
	2014-2015	34	89,2	8,69			
	2015-2016	27	88,4	4,33			
	2016-2017	20	89,5	7,59			
	2017-2018	20	89,1	4,77			
	Total	139	87,8	7,34			
Technological Pedagogical Content Knowledge- TPCK	2013-2014	38	83,6	5,5	4/134	6,38	0,000
	2014-2015	34	87,3	6,83			
	2015-2016	27	88	3,07			
	2016-2017	20	89	4,22			
	2017-2018	20	89,6	4,44			
	Total	139	87	5,58			

As a result of one-way ANOVA test, for education faculty candidates about TPACK Self Efficacy; technological knowledge, pedagogical knowledge, technological content knowledge and the whole scale means were found as there was a significant difference but there was no significant difference between content knowledge, pedagogical content knowledge and technological pedagogical knowledge means for the five years.

According to the Table 8, sub-dimensions and the scale values were calculated as; technological knowledge (TK) F134=12,139, p=0,000 (p<,05), pedagogical knowledge (PK) F134=9,795, p=0,000 (p<,05), content knowledge (CK) F134=1,035, p=0,391 (p>,05), technological pedagogical knowledge (TPK) F134=1,580, p=0,183 (p>,05); pedagogical content knowledge (PCK) F134=1,197, p=0,315 (p>,05); technological content knowledge (TCK) F134=2,885, p=0,025 (p<,05) and for the whole scale of TPACK F134=6,380, p=0,000 (p<,05). After the examined data of all years, one of the multiple comparison tests, Tamhane's T2 Test, was applied to determine the mean differences. As a result of this test, in 2013-2014, self-efficacy means of education faculty candidates TK, PK and TPACK self-efficacy means were found as a significant difference from the 2014-2015, 2015-2016, 2016-2017 years.

4. Discussion

In this study, it has been aimed to compare the TPACK self-efficacy of the prospective Biology teachers of Faculty of Education (FoE) and the Faculty of Science (FoS). The data were obtained from the comparison of the results of two different faculty candidates both on the basis of one academic year and also five academic years' means. For this purpose, answers of determined sub-problems were sought if there was a significant difference between them or not.

As a beginning, the TPACK self-efficacy of the prospective Biology teachers of FoE and FoS were analyzed separately in the five academic years of 2013-2014 and 2017-2018. According to the results of the data, it was determined that there was a significant difference between the prospective Biology teachers of two different faculties. The data were analyzed under the six sub-dimensions: TK, PK, CK, TPK, PCK, TCK and the whole scores of TPACK Self-efficacy with each of 2014 and 2018 academic years. As a result, it was found that the prospective Biology teachers of the FoE have higher TPACK self-efficacy scores than the FoS.

In the literature, there are various studies comparing the self-efficacy perceptions of teacher candidates of the faculty of science and faculty of education(Arastaman, 2013; Aslan, Uluçınar Sağır, & Elmas, 2020; Öztürk, Doğan, & Koç, 2005). Aslan, Uluçınar Sağır, & Elmas; 2020). These studies results were revealed that the self-efficacy beliefs

towards science teaching of pre- service science teacher students of the faculty of education were higher than the students of the science and literature faculty who received pedagogical formation education. This result is similar to the results of the study. Arastaman (2013) was found that the education faculty students' self-efficacy perceptions were higher than the faculty of arts and science students'. As a result of this, it was emphasized that the high self-efficacy perception of education faculty students regarding the teaching profession can be explained by the effect of the vocational knowledge courses in the programs of the education faculties. Öztürk, Doğan &Koç (2005) were compared teaching skills, career choice and exalting teaching factors of the education and arts-sciences faculty students. As a result of this, the perceptions of the education faculty students concerning the teaching profession are more positive values than the faculty of arts and sciences students. As contrary to these results Elkatmış, Demirbaş & Ertuğrul (2013) were found that there was no significant difference of the comparison between the education faculty and faculty of arts and sciences students about their self-efficacy and teaching profession.

Some study results has revealed that pre-service teachers of the education faculties have high level technopedagogical knowledge competency (Abbitt, 2011; Balçın & Ergün, 2018; Çoklar, 2014; Kabakçı Yurdakul,2011; Çuhadar, Bülbül & Ilgaz, 2013; Joo, Park, & Lim, 2018; Scherer, Tondeur &Siddiq, 2017; Semiz & Ince, 2012; Taflı & Atıcı,2018) but some of the studies that was applied to pre-service teachers of the pedagogical formation certificate program that they had medium or low level technopedagogical knowledge. Demir & Fırat Durdukoca (2018) were studied with only the pedagogical formation certificate program students' TPACK levels. As a result of the study they found that these students have lower scores about TPACK. In another studies, Yağcı (2016) and Gönen &Kocakaya (2015) was applied the TPACK sufficiency scale to the pedagogical formation certificate program students and according to the result it was found that the scores of these students' TPACK levels were on medium level. Likewise the study results, the comparison of the TPACK self- efficacy levels between the faculty of education and faculty of science were found as significant differences. Akgün, Özgür & Çuhadar (2016) were determined that TPACK competencies of education faculty students and pedagogical formation training program students were both at middle level but the comparison of average scores were found highly scores in favor of the education faculty students. Üzel & Mert Uyangör (2018) were also compared the TPACK self-efficacy of mathematics teacher candidates between the faculty of education and pedagogical formation education certificate program. They were also found that there was a meaningful difference between TPACK scores of these two groups.

Another result of this study, the TPACK self-efficacy mean scores of the prospective Biology teachers of these two faculties, FoE and FoS, were analyzed between the five academic years' averages separately. According to the results all sub dimension points

and the whole scale points of TPACK self-efficacy were also found as a significant difference between 2013-201 and 2017-2018 academic years.

5. Conclusion

Teacher self-efficacy is started to form from the first year of the Bachelor's degree students in the faculty of education and it is shaped by the gained experiences during the whole teaching process. When compared to the prospective teachers who receives the pedagogical formation certificate program after their graduation from the faculty of science, the teaching process and the training applications are only limited to 6-9 months. But prospective teachers of the education faculty have also been trained with the awareness of teaching for a long time and have the richness of experience during the undergraduate education. For these reasons, it is not surprising that Education faculty candidates' self-efficacy levels are higher than those of science faculty candidates. Teaching skills and self-efficacy are not a process that can be gained in a short time. For this reason, the right to become a teacher should only be given to education faculty students.

References

Abbitt, J. T. (2011). An Investigation of the relationship between self-efficacy beliefs about technology integration and technological pedagogical content knowledge (TPACK) among preservice teachers. *Journal of Digital Learning in Teacher Education, 27*(4), 134–143. **https://doi.org/10.1080/21532974.2011.10784670**

Akgün,F., Özgür, H., & Çuhadar, C. (2016). The investigation of technopedagogical knowledge competencies of teacher candidates and pedagogical formation students. *Adıyaman University Social Sciences Institute Journal*, 24, 837-871**. https://dergipark.org.tr/tr/pub/adyusbd/issue/37218/429580**

Angeli, C., & Valanides, N. (2005). Preservice elementary teachers as information and communication technology designers: an ınstructional systems design model based on an expanded view of pedagogical content knowledge. *Journal of Computer Assisted Learning, 21*(4), 292–302. **https://doi.org/10.1111/j.1365-2729.2005.00135.x**

Arastaman, G. (2013). Examination of education and arts and sciences faculty students' self-efficacy beliefs and their attitudes toward teaching profession. *Ahi Evran University Kırşehir Education Faculty Journal,14*(2), 205-217.**https://dergipark.org.tr/en/pub/kefad/issue/59471/854608**

Aslan, O., Uluçınar Sağır, Ş., & Elmas, C. (2020). Comparison of self-efficacy beliefs towards science teaching of preservice science teachers and the faculty of science and literature students receiving pedagogical formation education. *International Journal of Turkish Educational Studies, 8* (14), 15-29. **http://doi.org/10.46778/goputeb.616983**

Bakar, N. S. A., Maat, S. M., & Rosli, R. (2020). Mathematics teacher's self-efficacy of technology integration and technological pedagogical content knowledge. *Journal on Mathematics Education*, *11*(2), 259–276. **https://doi.org/10.22342/jme.11.2.10818.259-276**

Balçın, M.,, & Ergün, A.(2018). Determination of technological pedagogical content knowledge (TPACK) self-efficacy of science teacher candidates and analysis of them according to various variables. *Mehmet Akif Ersoy University Education Faculty Journal* , 45, 23-47. http://doi.org/**10.21764/maeuefd.311316**

Bandura, A. (1997*). Self-efficacy: The exercise of control.* New York: Freeman.

Blonder, R., & Rap, S. (2017). I like Facebook: Exploring Israeli high school chemistry teachers' TPACK and self-efficacy beliefs. *Education and Information Technologies*, 22, 697–724 **tps://doi.org/10.1007/s10639-015-9384-6**

Byker E.J., Michael Putman S., Polly D., & Handler L. (2018). Examining elementary education teachers and preservice teachers' self-efficacy related to technological pedagogical and content knowledge (TPACK). In: Hodges C. (Eds) *Self-efficacy in instructional technology contexts*. Springer, Cham. **https://doi.org/10.1007/978-3-319-99858-9_8**

Cox, S., & Graham, C. R. (2009). Diagramming TPACK in practice: Using an elaborated model of the TPACK framework to analyze and depict teacher knowledge. *TechTrends: Linking Research & Practice to Improve Learning*, *53*(5), 60-69. **https://link.springer.com/content/pdf/10.1007/ s11528-009-0327-1.pdf**

Çakıroğlu, J. , Çakıroğlu, E. & Boone, W. J. (2005). Pre-service teacher self-efficacy beliefs regarding science teaching: A comparison of pre-service teachers in Turkey and the USA. *Science Educator, 14*(1), 31-40. **https://files.eric.ed.gov/fulltext/EJ740956.pdf**

Çoklar, A .N. (2014). Primary school preservice teachers' technological pedagogical content knowledge competency in terms of gender and ICT use phase. *Education and Science, 39* (175): 319-330. **http://doi.org/10.15390/EB.2014.3464**

Çuhadar, C., Bülbül, T. & Ilgaz, G. (2013). Exploring of the relationship between individual innovativeness and techno-pedagogical education competencies of pre-service teachers. Elementary Education Online, 12(3), 797-807**. https://www.ilkogretim-online.org/fulltext/218-1597070028.pdf?1623846207**

Demir, T., & Fırat Durdukoca, Ş (2018). Investigation of technological pedagogic content information by various variables of students' continuing pedagogical formation education certificate program. *International Journal of Turkish Literature Culture Education, 7*(2), 1253-1275. **http://dx.doi.org/10.7884/teke.4173**

Dong, Y., Xu, C., Chai, C.S. & Zhai, X. (2020). Exploring the structural relationship among teachers' technostress, technological pedagogical content knowledge (TPACK), computer self-efficacy and school support. *The Asia-Pacific Education Researcher, 29***,** 147–157. **https://doi.org/10.1007/s40299-019-00461-5**

Doukakis, S., Koilias, C., & Chionidou-Moskofoglou, M. (2011). An undergraduate primary education teaching practicum design and undergraduate primary teachers' satisfaction on developing technological, pedagogical and mathematical knowledge. *International Journal of Teaching and Case Studies, 3*(2-4), 180-195. **https://doi.org/10.1504/IJTCS.2011.039557**

Elkatmış, M., Demirbaş, M., & Ertuğrul, N. (2013). Self-efficacy beliefs of students who take the pedagogic training program in the faculty of arts and sciences and students in the education faculty towards teachıng profession. *Pegem Journal of Education & Instruction, 3(*3), 2013, 41-50. **https://doi.org/10.14527/C3S3M4**

Fraenkel, J.R &Wallen, N.E. (2009). *How to design and evaluate research in education*. New York: McGraw-Hill.

Gönen, S., & Kocakaya, F. (2015). Examing technopedogogic education sufficiencies of students join pedogogic formation programs according to some variables. *Journal of Research in Education and Teaching, 4*(4), 82-90. **http://www.jret.org/?pnum=43&pt=2015+C%C4%B0LT+4+SAYI+4**

Graham, C. R., Burgoyne, N., Cantrell, P., Smith, L., Clair, L. St., & Harris, R. (2009). TPACK development in science teaching: Measuring the TPACK confidence of ınservice science teachers. *Tech Trends*, *53* (5), 70-79**. https://link.springer.com/content/pdf/10.1007/s11528-009-0328-0.pdf**

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types curriculum-based technology ıntegration reframed. **https://doi.org/10.1080/15391523.2009.10782536**

Jin, Y., & Harp, C. (2020). Examining preservice teachers' TPACK, attitudes, self-efficacy, and perceptions of teamwork in a stand-alone educational technology course using flipped classroom or flipped team-based learning pedagogies. *Journal of Digital Learning in Teacher Education, 36*(3), 166-184. **https://doi.org/10.1080/21532974.2020.1752335**

Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK,teacher self-efficacy, and technology acceptance model. *Educational Technology & Society, 21*(3), 48–59. **https://www.jstor.org/stable/26458506**

Joo, Y., Park, S., & Lim, E. (2018). Factors Influencing Preservice Teachers' Intention to Use Technology: TPACK, Teacher Self-efficacy, and Technology Acceptance Model. *Journal of Educational Technology & Society, 21*(3), 48-59. **https://www.jstor.org/stable/26458506**

Kabakçı Yurdakul, I. (2011). Examining technopedagogical knowledge competencies of preservice teachers based on ICT usage. Hacettepe university Journal of Education, 40, 397- 408. **http://www.efdergi.hacettepe.edu.tr/shw_artcl-424.html**

Kapıcı, H.O., & Akcay, H. (2020). Improving student teachers' TPACK self-efficacy through lesson planning practice in the virtual platform, *Educational Studies,* 1-24. **https://doi.org/10.1080/03055698.2020.1835610**

Karasar, N. (2006). *Bilimsel Araştırma Yöntemi (Scientific Research Methods),* Ankara: Nobel

Kereluik, K., Mishra, P., & Koehler, M. J. (2011). On learning to subvert signs: Literacy, technology and the TPACK framework. *California Reader, 44*(2), 12-18. **http://eds.a.ebscohost.com/abstract**

Keser, H., Yılmaz, F. G. K., & Yılmaz, R. (2015). TPACK competencies and technology integration self-efficacy perceptions of pre-service teachers. Elementary Education Online, 14(4), 1193–1207. **http://dx.doi.org/10.17051/io.2015.65067**

Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research, 32*(2), 131–152. **https://doi.org/10.2190/0EW7-01WB-BKHL-QDYV**

Lee, E., Kim, S.W. & Lee, Y. (2017). An ınvestigation of the relationship between self-efficacy and technological pedagogical content knowledge (TPACK) among preservice Teachers. In J. Dron & S. Mishra (Eds.), *Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (pp. 627-631). Vancouver, British Columbia, Canada: Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/181238/.

Lee, M. H. & Tsai, C. C. (2010). Exploring teachers' perceived self-efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web. *Instructional Science, 38*(1), 1–21. **https://doi.org/10.1007/s11251-008-9075-4**

Lundeberg, M. A. , Bergland, M., & Klyczek, K. (2003). Using action research to develop preservice teachers' confidence, knowledge and beliefs about technology. *The Journal of Interactive Online Learning, 1*(4), 1-16. **http://www.ncolr.org/issues/jiol/v1/n4/index.html**

Margerum-Leys, J., & Marx, R. (2002). Teacher knowledge of educational technology: A study of student teacher/mentor teacher pairs. *Journal of Educational Computing Research, 26*(4), 427-462. **https://eric.ed.gov/?id=ED442763**

Moreira-Fontán, E., García-Señorán, M., Conde-Rodríguez, Á, & González, A. (2019). Teachers' ICT-related self-efficacy, job resources, and positive emotions: Their structural relations with autonomous motivation and work engagement. *Computers & Education, 134*, 63–77. **https://doi.org/10.1016/j.compedu.2019.02.007**

Nathan, E. J. (2009). *An examination of the relationship between preservice teachers' level of technology integration self-efficacy (TISE) and level of technological pedagogical content knowledge (TPACK).* Ph.D. Thesis, University of Houston.

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: developing a technology pedagogical content knowledge. *Teaching and Teacher Education, 21(*5), 509-523. **https://doi.org/10.1016/j.tate.2005.03.006**

Öztürk, B , Doğan, O., & Koç, G . (2005). Comparıng the perceptions of the students of faculty of education and arts and sciences concerning the teaching profession. *The Journal of Turkish Educational Sciences, 3* (1), 1-22.**https://dergipark.org.tr/en/pub/tebd/issue/ 26125/275196**

Pierson, M. (1999*). Technology practice as a function of pedagogical expertise*. PhD Dissertation ,Arizona State University,Arizona. UMI Dissertation Service, 9924200.

Pierson, M., & Borthwick, A. (2010). Framing the assessment of educational technology professional development in a culture of learning. *Journal of Digital Learning in Teacher Education, 26*(4), 126-131. **http://doi.org/ 10.1080/10402454.2010.10784645**

Scherer, R., Tondeur, J. B, Siddiq,F. (2017). On the quest for validity: Testing the factor structure and measurement invariance of the technology-dimensions in the technological, pedagogical, and content knowledge (TPACK) model. *Computers & Education*, 112, 1-17. **https://doi.org/10.1016/j.compedu.2017.04.012**

Semiz, K., & Ince, L. I. (2012). Pre-service physical education teachers' technological pedagogical content knowledge, technology integration self-efficacy and instructional technology outcome expectations. *Australasian Journal of Educational Technology, 28*(7), 1248–1265. **https://doi.org/10.14742/ajet.800**

Setiawan, H & Phillipson, S. (2020). The correlation between social media usage in academic context and self-efficacy towards TPACK of prospective science teachers in Indonesia. *Journal of Science Learning, 3*(2).106-116 **https://files.eric.ed.gov/fulltext/EJ1251793.pdf**

Shulman, L. S. (1896). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14. (AERA Presidential Address). **https://doi.org/10.3102/0013189X015002004**

Şimşek, Ö., & Sarsar, F. (2019). Investigation of the self- efficacy of the educators in technological pedagogical content knowledge and their use of ınformation and communication technologies. *World Journal of Education, 9* (1), 196- 208. **https://doi.org/10.5430/wje.v9n1p196**

Taflı, T., & Atıcı, T. (2018). Determination of pre-service biology teachers' self-efficacy towards technological pedagogical content knowledge. *The Journal of International Social Research, 11* (61), 697-706. **http://doi.org/10.17719/jisr.2018.2962**

Tschannen-Morana, M., & Woolfolk Hoyb, A. (2001). Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education, 17*, 783–805 **https://doi.org/10.1016/S0742-051X(01)00036-1**

Üzel, D. & Mert Uyangör, S. (2018). Comparison of technologic pedagogic content knowledge of faculty of education mathematics teacher candidates and pedagogical formation education certificate program candidates. *Turkish Studies Educational Sciences, 13*(27),1593-1607. **http://eds.a.ebscohost.com/eds/pdfviewer/pdfviewer?vid=0&sid=7f9ce495-20c5-42e2-901a-415897d0dc8e%40sdc-v-sessmgr01**

Wang, L., Ertmer, P. A., & Newby, T. J. (2004). Increasing pre-service teachers' self-efficacy beliefs for technology integration. Journal of Research on Technology in Education, 36(3), 231-250. **https://doi.org/10.1080/15391523.2004.10782414**

Yağcı, M. (2016). Investigation of techno-pedogogical sufficiency of prospect pedagogical formation education teachers in terms of several variables. Kastamonu Education Journal, 24(3), 1327-1342. **https://dergipark.org.tr/tr/pub/kefdergi/issue/22607/241625**

Yerdelen-Damar, S., Boz, Y. & Aydın-Günbatar, S. (2017). Mediated effects of technology competencies and experiences on relations among attitudes towards technology use, technology ownership, and self efficacy about technological pedagogical content knowledge. Journal of Science Education and Technology, 26,394–405. **https://doi.org/10.1007/s10956-017-9687-z**

Yıldız Durak, H. (2019): Modeling of relations between K-12 teachers' TPACK levels and their technology integration self-efficacy, technology literacy levels, attitudes toward technology and usage objectives o objectives of social networks. *Interactive Learning Environments*, 1-27. **https://doi.org/10.1080/10494820.2019.1619591**